REPORT NO. NADC-81268-60

DEVELOPMENT OF POLYTETRAFLUOROETHYLENE ANTI-EXPOSURE SUITS

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NAVAL AIR DEVELOPMENT CENTER
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30 October 1981

INTERIM REPORT

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Prepared for
NAVAL AIR SYSTEMS COMMAND
Department of the Navy
Washington, D.C. 20361

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER NADC-81268-60	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* DEVELOPMENT OF POLYTETRAFLUOROETHYLENE ANTI-EXPOSURE SUITS		5. TYPE OF REPORT & PERIOD COVERED Interim 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Jules Z. Lewyckyj		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Aircraft and Crew Systems Technology Directorate Naval Air Development Center Warminster, PA 18974		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Air Systems Command (AIR-531) Department of the Navy Washington, D.C. 20361		12. REPORT DATE 30 October 1981 13. NUMBER OF PAGES 50
14. MONITORING AGENCY NAME & ADDRESS*(if different from Controlling Office)*		15. SECURITY CLASS. *(of this report)* Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*

Approved for Public Release; Distribution Unlimited.

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Anti-Exposure Suits
Hypothermia
Aircrew Protection
Polytetrafluoroethylene Film

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

Provide a description of the development of a PTFE three-layer fire-resistant waterproof anti-exposure suit for use by Navy and Air Force aircrew. Five prototype fabric laminates were developed and garments were manufactured for operational testing.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102-LF-014-6601

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A C K N O W L E D G E M E N T

The author acknowledges the contributions and participation of the following (and the activities they were associated with):

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A. Hellman	Naval Air Development Center
R. Pursell	Naval Air Development Center
W. Schrandt	Naval Air Development Center

Introduction

This report describes the development of a laminated anti-exposure suit which will replace the presently used anti-exposure suits made of cotton "ventile" material (U.S. Navy CWU-59/P, U.S. Air Force CWU-21/P). The new suit will be manufactured of a laminate composed of an aramid face and back fabric with a polytetrafluoroethylene (PTFE) film innerlayer. The design would be the same as the presently used suits. The laminate shall provide an external waterproof capability, fire resistance, and will reduce or eliminate internal heat build-up by permitting wearer produced moisture to pass out thru the three layer laminate.

Both the U.S. Navy and the Air Force use the cotton "ventile" suits. The program to replace the cotton ventile with a PTFE laminate is being conducted by both services. The Naval Air Development Center, as the Lead Tri-Service Laboratory for aircrew flotation equipment and aircrew anti-exposure clothing has the responsibility for managing and coordinating the development, acquisition and logistic support for the PTFE anti-exposure suit program ref. (a).

Development of the Polytetrafluoroethylene Anti-Exposure Suit

In the early 1970's, the Celanese Plastics Co., Greer, SC, a division of Celanese Corp. developed a microporous polypropylene film called "Celgard". This microporous film would permit passage of moisture but prevent water passage. "Celgard" was available in various thicknesses and could be fused to woven or mesh polypropylene. Although it was suggested that "Celgard" could be bonded to other materials, such laminates were never available. Since the polypropylene - "Celgard" laminate was flammable these materials were not considered for an anti-exposure suit.

W. L. Gore and Associates, Inc. (Elkton, MD) started development of PTFE laminate in the mid 1970's. From 1971 through 1974, the company manufactured and sold PTFE film, sheeting and tubing. In Jan. 1976, a waterproof, moisture transmitting laminate had been developed by the company and was being marketed. This laminate used a microporous PTFE film as the internal member. The PTFE film was a stretched material which had very small pores (9×10^9 per square inch) thus permitting moisture transmission and preventing water passage. A scanning electron micrograph of the PTFE film is shown in Figure (1).

NAVAIRDEVCEN obtained from W. L. Gore a 10 yard sample of a laminate, composed of fire resistant aramid twill face, PTFE center, nylon tricot back. Some testing indicated that this material could be used to develop an anti-exposure suit. After these tests, NAVAIRDEVCEN in a letter to the Naval Air Systems Command (NAVAIR) (encl. (1)) requested funding to develop an anti-exposure suit to replace the cotton "ventile" suit. The problem was twofold: (1) the "ventile" fabric is fragile and body oils, perspiration and dirt affect the fabric integrity so that the suit develops leaks (2) the "ventile" fabric is made from Egyptian cotton yarn woven on old British looms and is difficult to obtain and maintain logistically. The NAVAIRDEVCEN proposal was to fabricate 16 garments from two sources, using the best available laminates. The task would include fabrication, immersion testing and fire-pit testing after checking various laminates for the best candidate materials.

The publication of an article on "Waterproof Breathable Laminates" by D. J. Gohlke and J. C. Tanner (ref. b.) discussed the factors involved in providing a satisfactory material for outerwear to maintain waterproofness and proper Moisture Vapor Transmission (MVTR). The MVTR for a resting subject, for wearer comfort, should be 350-600 grams vapor/meter^2/24 hours. Under exertion with a high outside temperature (100-120°F) the MVTR should be 2500. For waterproof capability, the material should withstand 25 psi water pressure. Outer abrasion and wear resistance are determined by the face layer of the laminate since the PTFE film alone cannot withstand abrasion.

NAVAIR wrote to NAVAIRDEVCEN (encl. 2) that the U.S. Air Force Life Support System Program Office would make $30,000 available to investigate PTFE laminates to replace cotton "ventile" for CWU-21/P suits. Only PTFE materials were to be investigated and a maximum number of suits must be made available to the U.S. Air Force for flight testing.

The investigation of PTFE laminates was an essential effort toward the development of an effective anti-exposure suit. A number of laminate composites were checked in the laboratory for technical characteristics (peel strength, breaking strength, water entry pressure, etc.). Five of these composites were developed from which 24 experimental garments were fabricated for physiological and fire-pit testing by the Navy. A Military Interdepartmental Purchase Request (encl.3) was issued by the Aeronautical Systems Division (AEL), Wright Patterson Air Force Base to NAVAIRDEVCEN for $20,000. This MIPR requested that PTFE laminates be investigated and that 24 suits be fabricated of the optimal laminate for an operational evaluation for the U.S.A.F.

NADC obtained some experimental, commercial PTFE fabric laminates, but these commercial samples were not acceptable because of the after flame results attributed to dying and anti-static treatments used on these fabric samples. In a progress report, (encl.4), NAVAIRDEVCEN reported on an investigation of 8 fire resistant outershell fabrics. These were tested for MVTR and adhesion. The fabrics were: Plain weave staple, Herringbone twill staple, Twill staple, Plain weave (type 456) staple, 2/2 Twill filament, Twill (calendered) staple, Cavalry Twill filament, and Warp knit filament. All were satisfactory for MVTR (between 3335 and 6584 grams/meter^2/24 hours) but only the Calendered Twill was unacceptable in its adhesion characteristics.

Four innershell fire resistant fabrics were evaluated: staple Jersey, staple Double knit, staple 1/4" Fishnet and staple Simplex. The Jersey was chosen as the innershell fabric to be laminated to the 5 best shell fabrics: staple Plain weave, type 456 staple Plain weave, filament 2/1 Twill; filament 2/2 Twill and filament Warp knit. Physiological and initial field tests showed that the garments manufactured from these laminates allowed breathability for comfort and were waterproof.

In Nov. 1979, a report was issued by NAVAIRDEVCEN which appeared in the SAFE Journal (30 Nov. 1979) (ref. (c)) on the physiological response of humans wearing thermal protective clothing:

> The tests were made on a selection of all the Free World service anti-exposure suits. After mobility tests, suits were evaluated for heat stress and underwent cold water testing.
>
> The events were: Mobility tests (24 measurements on each type of suit). Thermal chamber tests at 85°F (work task cycle with blood pressure, body temperature, heart rate, weight loss); Hypothermia test (45°F water, 32°F air, 20 mph wind).
>
> Test results: The PTFE suits ranked among the top suits tested. Mobility, heat test results, water test results were all satisfactory.

A follow-up report by the same authors on anti-exposure garment configuration effect on operational performance (ref. (d)) concluded that the PTFE laminate garment would perform better than a 2 layer cotton "ventile" and that the PTFE laminate garment did perform better than single layer cotton "ventile".

By 20 Oct. 1980, NAVAIRDEVCEN forwarded 24 suits made from five different laminated composites to the Air Force for test by 6520 Test Group. The face materials were as follows: (1) Warp knit filament (2) Plain weave (95% Nomex 5% Kevlar) staple (3) 2/2 Twill filament (4) 2/1 Twill staple (5) Plain Weave staple. All were completely fire resistant aramids.

In Oct.1980, the Air Force Flight Test Center, Edwards Air Force Base, issued their test plan for Development Test and Engineering (DT&E) of the microporous anti-exposure assembly (ref. (e)). It noted that the suit was developed by the U.S. Navy to determine whether the PTFE laminate was an acceptable substitute for cotton "ventile" in the CWU-21/P suit.

> The program would check breathability, waterproofness, wearability, durability, wearer physical mobility and pilot acceptability.
>
> The test period would last 4 months and would encompass the following aircraft: A-7, A-10, F-15, F-16, F-111, T-32, B-52.
>
> A UH-1 helicopter would be used as a drop/recovery for test parachutists.
>
> Mission Questionaries as well as instrumented cockpit physiological monitoring would be used to check out the following, as well as previously noted aspects:
>
> Pilot acceptability
> Swimming evaluation
> Parachute landing
> Parachute egress from the UH-1 over land or water

In Oct. 1980, a NAVAIR letter to NAVAIRDEVCEN (encl. 5) provided FY81 funding for the program:

(a) Evaluation of new materials and blends for use in thermally protective clothing - 30K
(b) Evaluation of microporous laminate materials for anti-exposure clothing - 20K

In Nov. 1980, NAVAIRDEVCEN issued a report on the results of the FED. STD-191 tests. These are tests on 5 laminates to be used in manufacture of PTFE anti-exposure suits. They involve 5 different fabrics to be used as the face of the laminates with PTFE film and Nomex Jersey knit back. There were 16 tests run on each of these laminates. The results are given on the following page, 6.

Beginning in Nov. 1980, the Naval Air Test Center, (NATC), Patuxent River, MD, conducted tests using fixed and rotary wing aircraft for 25 flight hours each.

Garments were tested for:

Durability
Compatibility with other flight gear
Acceptability by aircrewmen
Water tightness: parachute drag in a pool including parachute release and LPA-2 activation

In Mar. 1981, the Air Force reported on the PTFE suit results to NAVAIRDEVCEN in a letter (encl. 6). Tests were conducted in the pool, parachute jumps, salt water immersions and extended static wear with a number of machine washings between tests. It was noted by the Test Squadron that some suits leaked in the zipper area and previously suit patched areas. However, it should be noted that NAVAIRDEVCEN air inflation tests on the suits received from the Air Force showed that the suit leaks were caused by internal abrasion. This is shown in Figures 6 and 7.

In Mar. 1981, a test program was set up for testing the PTFE Anti-Exposure suits for leaks after operational testing. The procedure consists of inflating the suit (which has been turned inside out) with air at a pressure of 8" H_2O and checking for leaks with soapy water. The equipment, shown with suit under test in Figure 2, consists of a rectangular cabinet with an aluminum tray on top, onto which is placed the PTFE suit for test. An air blower (Figure 3) is placed at the bottom of the cabinet and is connected to the suit by a hose and 4½" pipe (Figure 4) which fits into the suit neck and is strapped there. The detergent solution is delivered by a pump (Figure 5) to a spray nozzle and sprayed over the air inflated suit. The solution running off the suit is collected by the aluminum tray and drains into the collection container (Figure 5) placed below the cabinet. The pump, inside the container, recirculates the detergent solution to the spray nozzle.

Leaks in the suit are indicated by soap bubbles formed at the leak points when the detergent solution is sprayed on the leak.

NAVAL AIR DEVELOPMENT CENTER

REPORT OF TESTS

PROJECT ENGINEER

Jules Z. Lewyckyj

W 14 > C 14 >	W 12.98 F 11.71	W 14.0 > F 14.0 >	W 14.0 > F 11.63	W 4.96 lbs. F 7.79	Tearing Strength Pendulum Method FTMS 191-5132
F 2.7 B 2.1	- -	F 2.2 B 2.0	F 2.3 B 3.4	F 1.4 B 1.7	After Weathering FTMS 191-5804 Face-Back Separation
F 3.6 B 2.4	- -	F 2.6 B 3.7	F 3.1 B 3.4	F 3.0 B 2.5	Adhesion of coating FTMS 191-5970
1 no blocking	-	1 no blocking	1 no blocking	1 no blocking	Blocking FTMS 191-5100
Aft.fl. Char W 1.5 1.8 F 0.6 1.8	Aft.fl. Char W 0 2.9 F 0 2.9	Aft.fl. Char W 0 2.7 F 0 2.3	Aft.fl. Char W 0 3.3 F 0 2.8	Aft.fl. Char W 0 4.4 F 0 4.1	Vertical flame test FTMS 191-5903 Avg.
All test samples meet requirements of test					Horizontal burn FTMS 191-5906
	W 244.6 F 146.6	W 398.0 F 372.0	W 216.0 F 130.8	W 81.4 F 89.2	Breaking Strength FTMS 191-5100
50	50	50	50	50	Water Repellency AATCC 22
-	106.4%	43.3%	86.8%	98%	Seam Efficiency FTMS 191-5110
287.0 psi	82.4 psi	255 psi	157.4 psi	78.4 psi	Hydrostatic FTMS 191-5512
F B W29.2 W24.4 C23.8 C26.0	F B W70.4 W28.6 F47.0 C29.4	F B W99.4 W28.2 F86.6 C30.0	F B W124.0 W28.8 F 78.0 C29.0	F B W76 W24.6 F67.6 C31.2	Face & Back Count per inch FTMS 191-5070
W 80.1 C114.4	W 69.7 F 79.0	W 78.9 F 85.3	W 87.2 F 73.0	W 39.2 lbs. F 54.9	Trapezoid Tear Strength FTMS 191-5136
No evidence of cracking	No evidence of cracking	No evidence of cracking	No evidence of cracking	No evidence of cracking	Flexing Endurance 100,000 cycles U.S. Testing Meth.
Av. 456.2	Av. 241.0	Av. 426.0	Av. 234.0	Av. 127.2	Bursting Strength FTMS 191-5120
L 2489 W 2357	W 1158 F 2757	W 2114 F 1259	W 796 F 946	W 553 F 527	Resistance to Abrasion ASTM D 1175
Nil	Nil	Nil	Nil	Nil	ASTM D 1175 Taber Abr. Weight Loss
10.75	6.67	7.68	6.49	3.89	Weight oz/sq.yd
Warp Knit Filament Sage Green	Plain Weave 95% NOMEX 5% KEVLAR Staple Sage Green	2/2 Twill Filament Sage Green	2/1 Twill Staple Orange	Plain Weave Staple White	

Repairs are made by using heat sealable patching material for the leaks in the fabric and heat sealable tape at the seams. The patches and tape are applied inside the suit using a heat sealer pressing the patch or tape onto the suit with a sealing temperature of 350°F for 15 seconds. The Heat Seal Machine is shown in Figure 8. It consists of a heat sealing platen which is pressed down onto an anvil placed below it. The suit area requiring sealing is placed on the anvil, the patching material or tape is positioned on the suit and the heated platen is pressed down onto the area below.

The leak test program was set up at NAVAIRDEVCEN to check the method that could be incorporated into the final PTFE suit specification and to check out experimental suits after the operational evaluation.

In May 1981, the Talon Division of Textron Inc., Meadville, PA provided literature on the OEB zipper fastener which provides a water tight and airtight seal. Its application is critical: neither adhesive nor the stitch line must encroach on the sealing area. Heavy lateral loads may not be applied. The sealing is accomplished by the tips being held together in compression by the engaged locking elements. The OEB fastener is pressure tested prior to shipment.

In June 1981, a message (encl. 7) from NATC, Patuxent River, MD, to NAVAIRDEVCEN provided a first interim report on 9 suits made of the five different laminates. They were checked in accordance with the test procedure outlined in enclosure (8). In total the 9 suits were worn for 300 flight hours varying between 4 and 102 hours for each suit. There was no significant difference in fabric durability between the five types. In addition, all five types were judged acceptable for wear by the aircrews.

Based on Edwards Air Force Base, CA and NATC, Patuxent River, MD test results showing that all suit laminates performed satisfactorily in the test programs, the laminate with the best combination of properties obtained in laboratory tests (as detailed on page 6) will be chosen for the final suit material. The laminate chosen for further testing is the Plain Weave (95% Nomex, 5% Kevlar) staple face with PTFE film and Jersey knit fire resistant aramid back.

NAVAIRDEVCEN has signed a contract for delivery by Dec 1981 of PTFE suits using a new heat sealed seam tape to be used instead of currently used cemented tape. This new tape is a three layer tape combining a thermoplastic adhesive, a high temperature waterproof layer and a fire resistant aramid knit face. The tape is designed for application to the inside of garment seams and, when applied with heat and pressure, provides a waterproof seam. The tape (7/8" wide) can be used on three layer PTFE laminates, on seams, wrist and neck seals, and around the booties. After receipt of the garments, NAVAIRDEVCEN will conduct tests on the efficacy of the tapes for the intended usage.

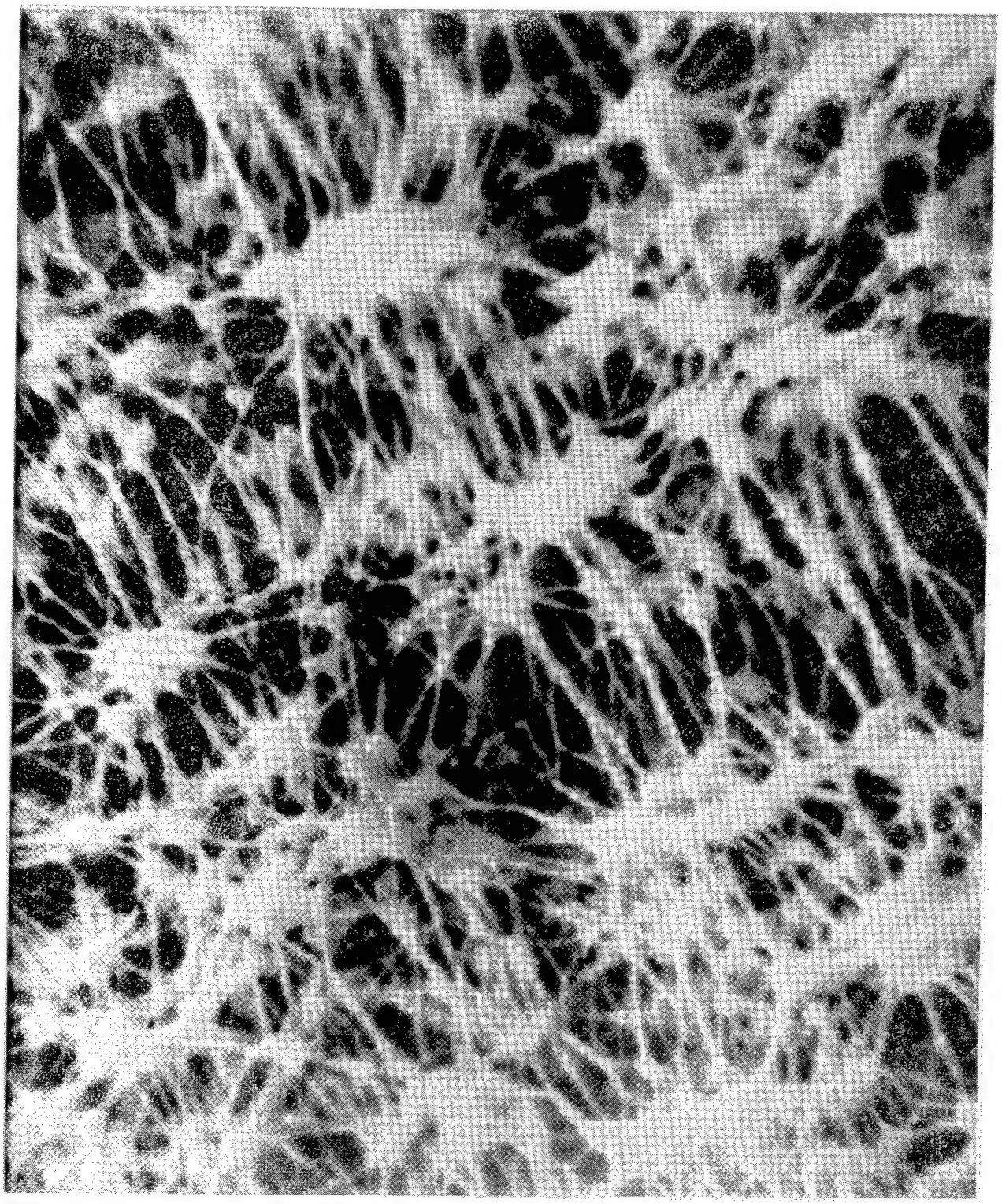
Figure 9 shows the PTFE Anti-Exposure Suit worn with a standard Life Preserver, Helmet, Gloves and Boots. It is noted the knees, elbows and wrist/neck seals are made from chloroprene coated fabric for required stretch.

NAVAIRDEVCEN will submit an Implementation Plan for the CWU-59A/P (the PTFE Anti-Exposure Suit) worn with the CWU-23/P inner liner, the SKU-25/P socks and the CWU-27/P outer coverall. Action is underway to eliminate the CWU-27/P entirely and to introduce PTFE booties to replace the SKU-25/P socks.

REFERENCES

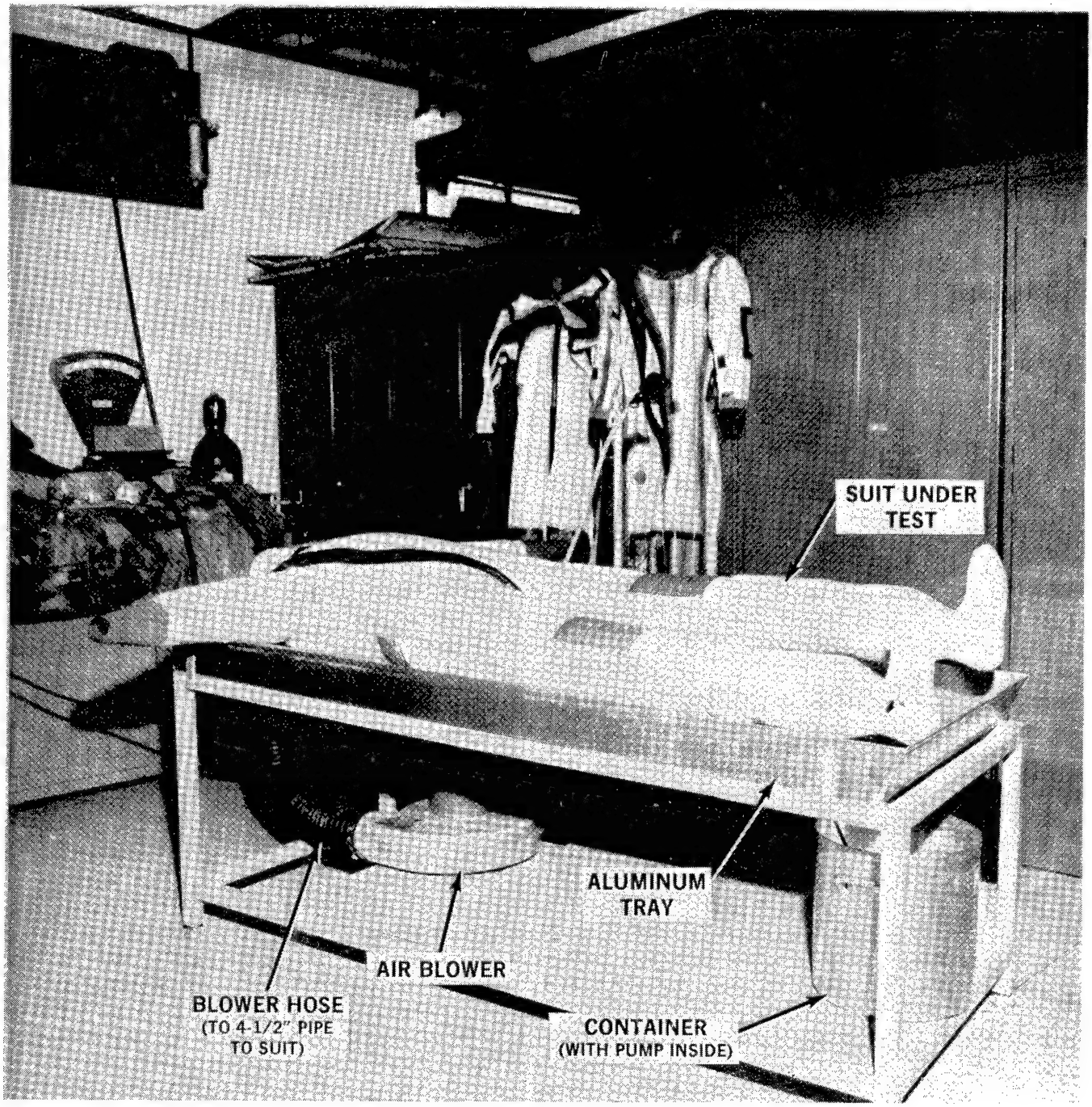
(a) Chief of Naval Material letter to C.O., Naval Air Development Center, MAT 051:SRG of 7 June 1972.
(b) "Gore-Tex Waterproof Breathable Laminates" D. J. Gohlke and J. C. Tanner June 1977.
(c) "Physiological Responses of Human Subjects Wearing Thermal Protective Clothing Assemblies in Varying Environments" D. C. Johanson, S. M. Reeps, L. J. Santa Maria. SAFE Journal, Nov. 1979.
(d) "Evaluation of a Selected Group of Anti-Exposure Configurations for their Effects on the Operational Performance and Survival of Naval Aircrewmen", D. C. Johanson, S. M. Reeps, L. J. Santa Maria.
(e) "Test Plan for DT&E Microporous Anti-Exposure Assembly" of 24 Oct 1980. A/F Flight Test Center, Edwards A/F Base, CA.

APPENDIX A
FIGURES



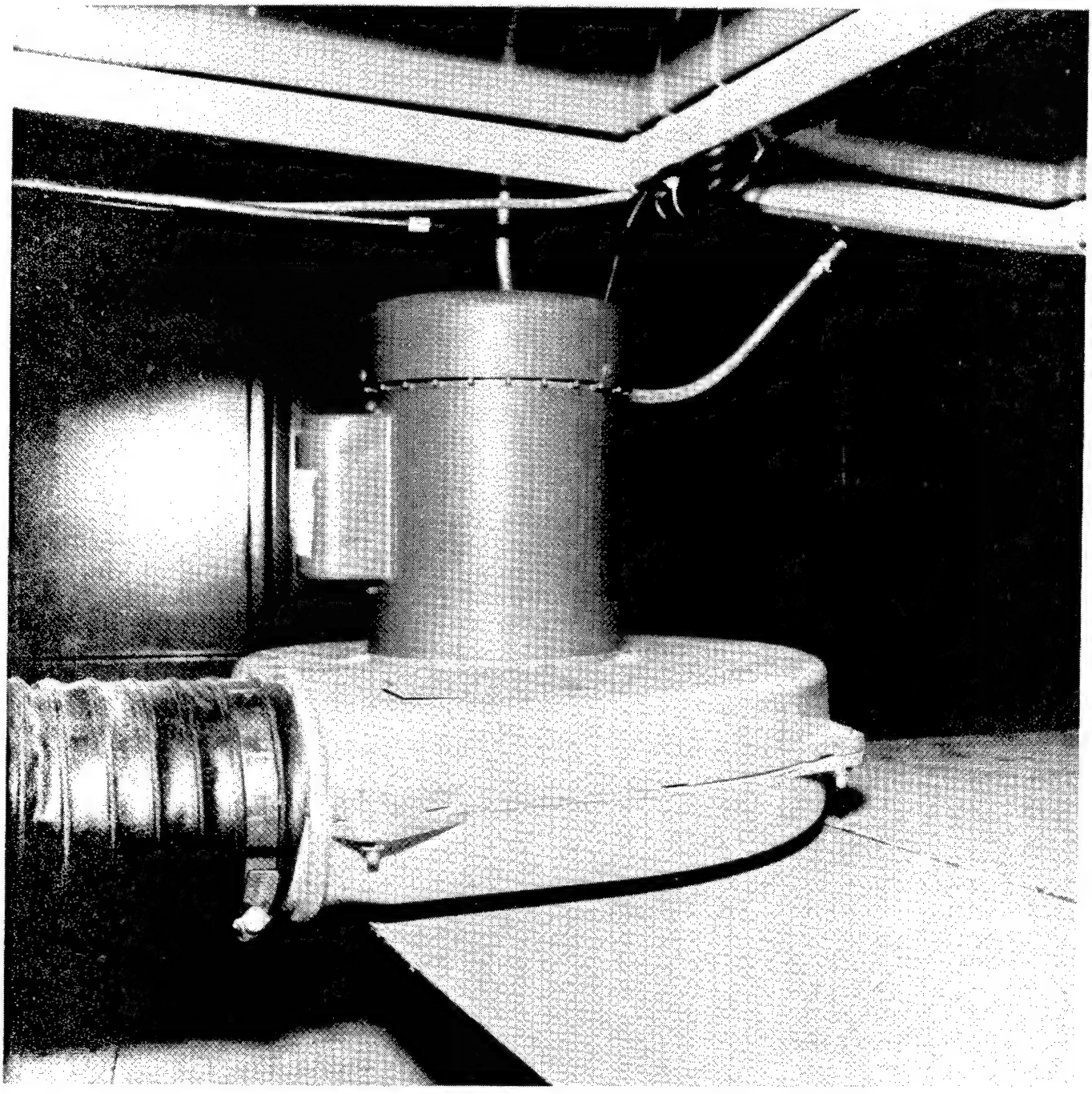
PTFE FILM
SCANNING ELECTRON MICROGRAPH
(ORIGINAL MAGNIFICATION 5000X)

FIGURE 1



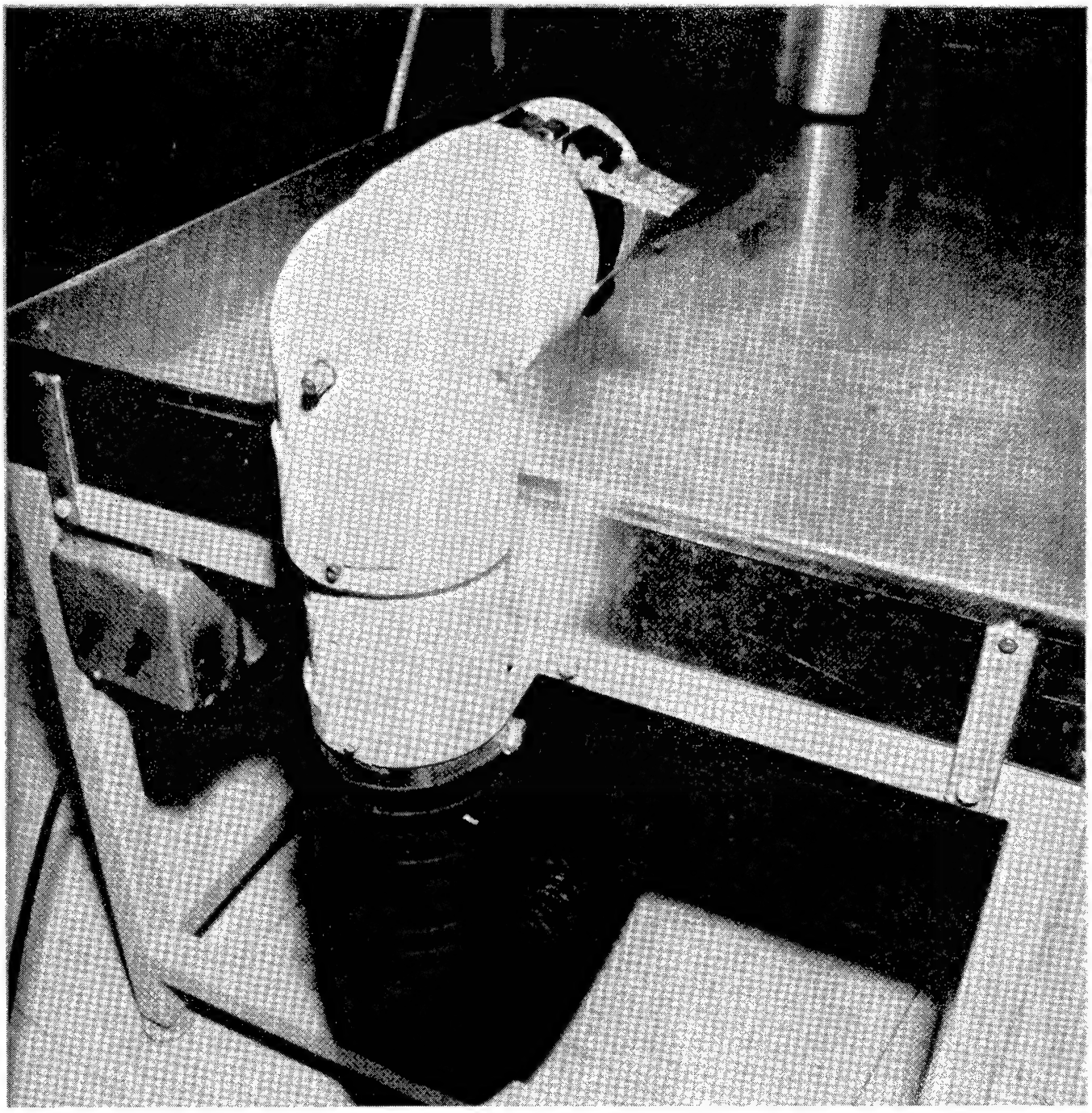
PTFE ANTI-EXPOSURE SUIT UNDER TEST

FIGURE 2



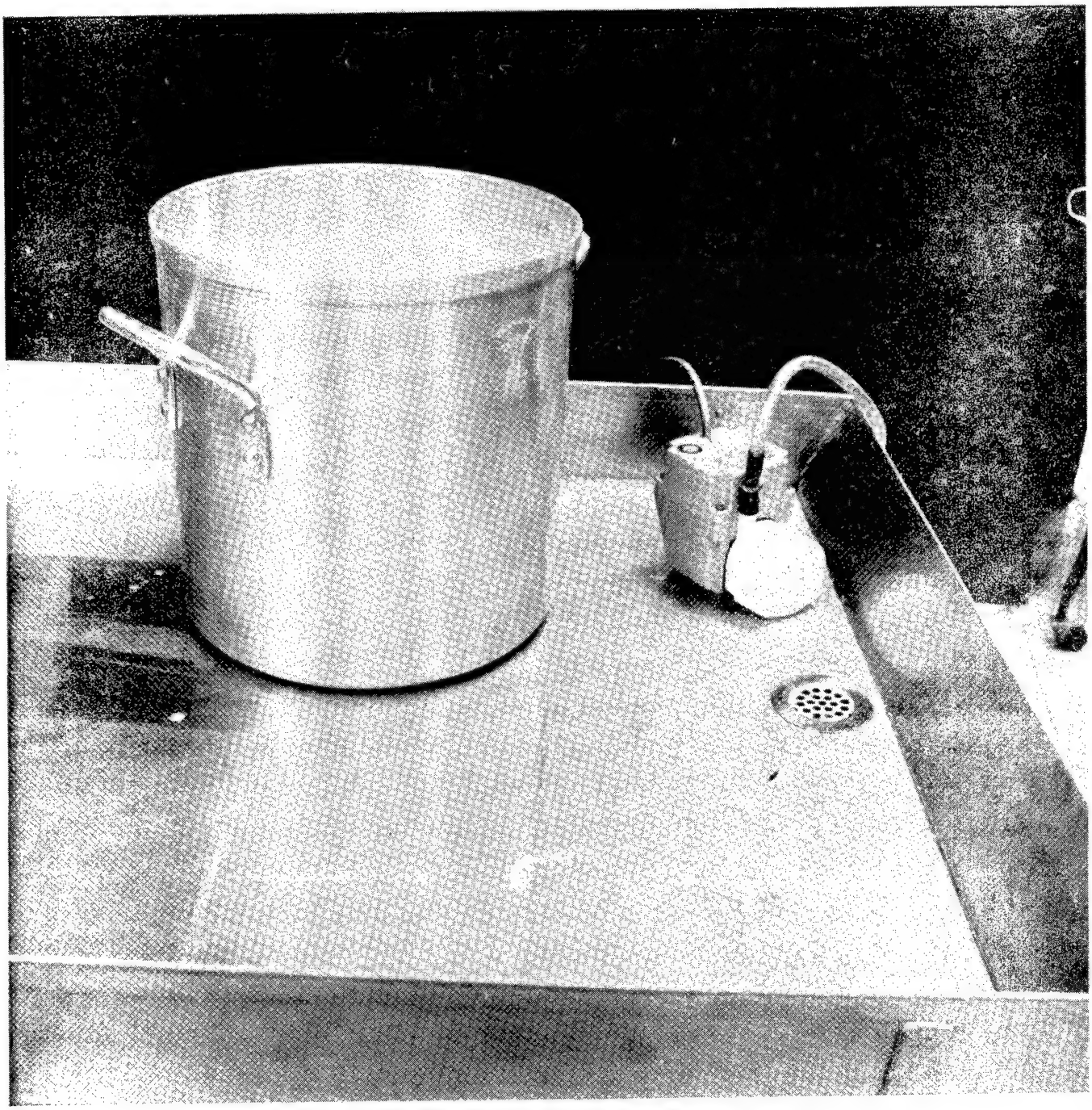
AIR BLOWER

FIGURE 3



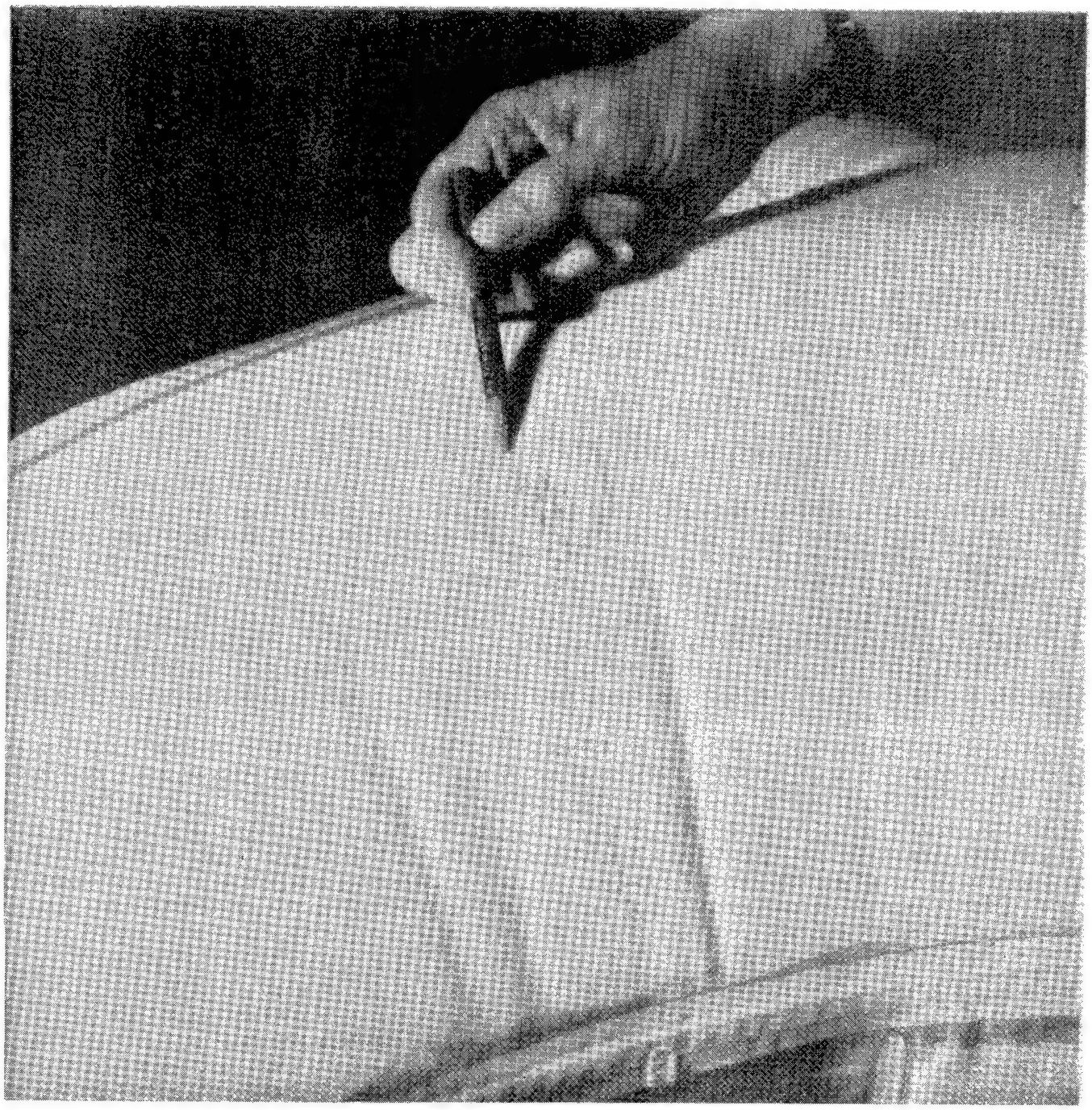
4-1/2" PIPE CONNECITON
(TO SUIT COLLAR)

FIGURE 4



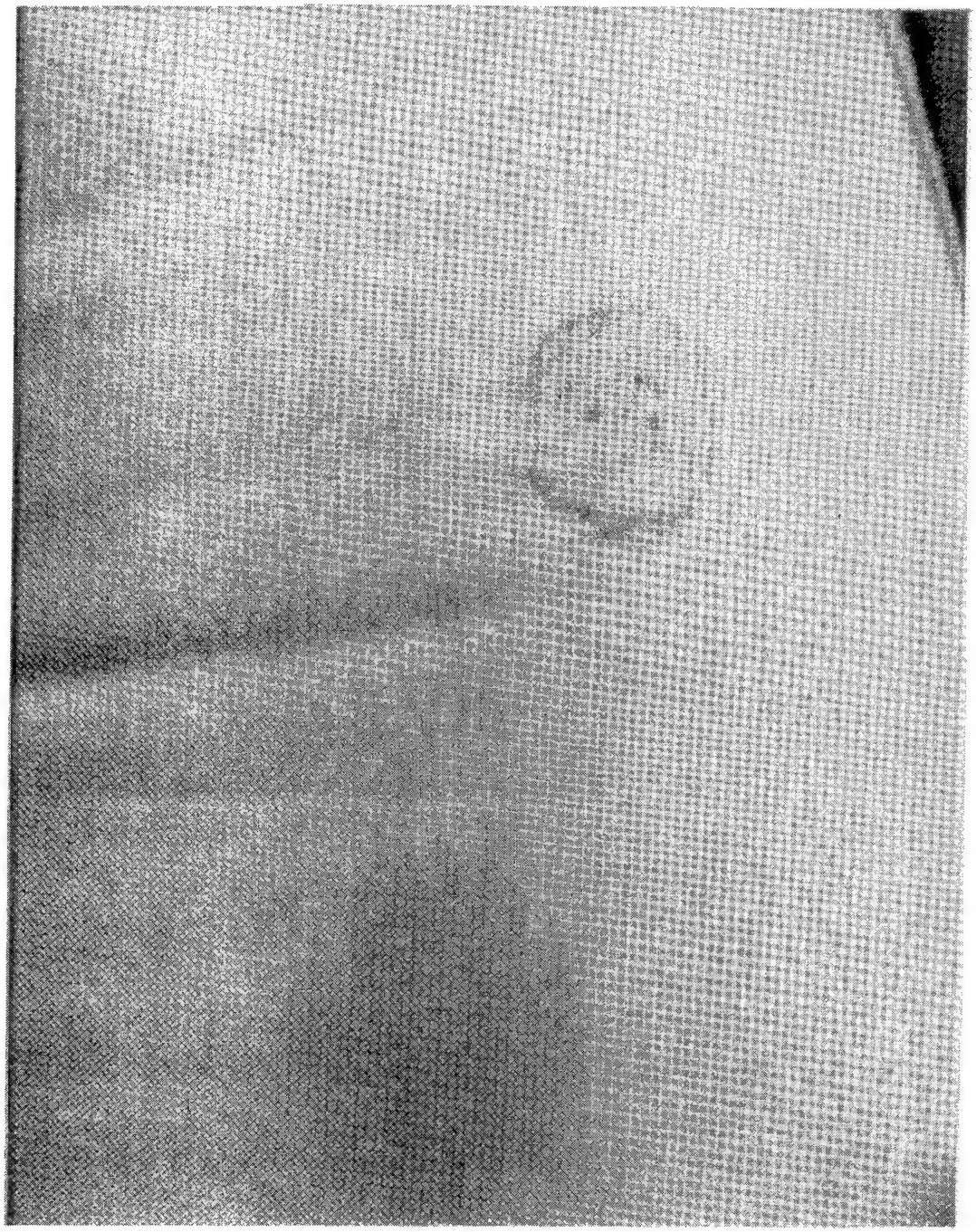
DETERGENT COLLECTION CONTAINER & DETERGENT PUMP

FIGURE 5



FAILURE CAUSED BY
BELT BUCKLE ABRASION
(BELT BUCKLE WORN ON TROUSERS INSIDE SUIT)

FIGURE 6



FAILURE CAUSED BY ABRADING OBJECT (CAUSE UNKNOWN)

FIGURE 7

HEAT SEALING MACHINE

(HEAT SEALER, TOP, WITH ANVIL UNDER SUIT BEING PATCHED)

Figure 8

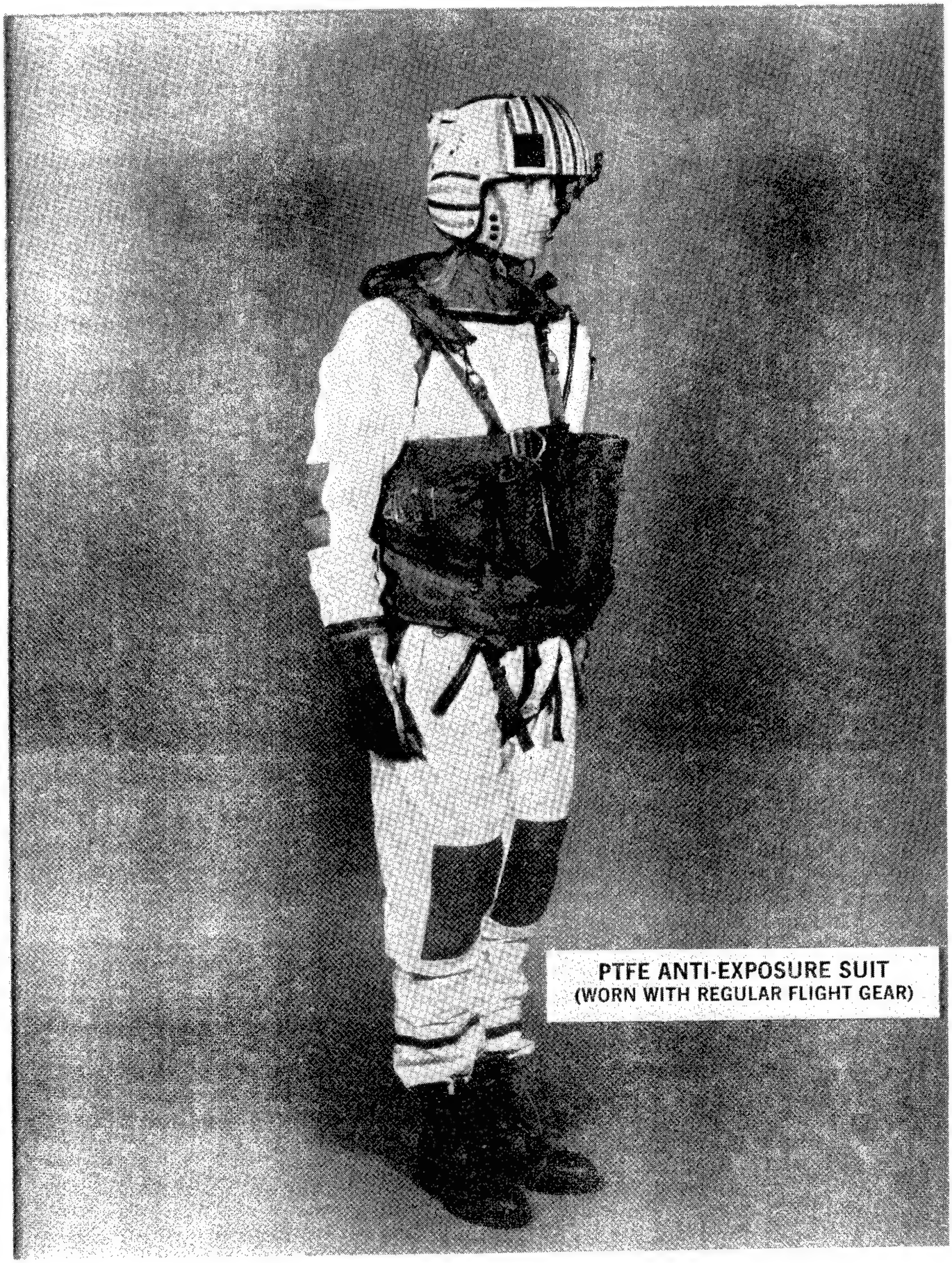


FIGURE 9

APPENDIX B
ENCLOSURES

DEPARTMENT OF THE NAVY
NAVAL AIR DEVELOPMENT CENTER
WARMINSTER, PA. 18974

404314
9345
19 NOV 1976

From: Commander, Naval Air Development Center
To: Commander, Naval Air Systems Command (AIR-531)

Subj: Experimental Anti-Exposure Suit Program; request funding for

Ref: (a) Mtg held at NAVAIR between Mr. Lionel Weinstock (AIR-5311D), NAVAIR, and Mr. J. Lewyckyj (404314), NAVAIRDEVCEN, of 1 Oct 76
(b) Fonecon between Mr. L. Weinstock (AIR-5311D), NAVAIR, and Mr. J. Lewyckyj (404314), NAVAIRDEVCEN, of 8 Oct 76

Encl: (1) Milestone Chart

1. References (a) and (b) established an interest in the investigation of several synthetic "waterproof" but permeable materials for anti-exposure assemblies that could possibly replace the British "Ventile" fabric. The benefits accrued from developing a domestic fabric source vice purchasing from a dual foreign source (English fabric, Egyptian cotton fiber) are self-explanatory. The materials under consideration permit the venting out of perspiration in vapor form and the flow of air into the garment for ventilation while maintaining a "waterproof" status when immersed in water. These materials would substantially increase aviator comfort over present materials used in anti-exposure clothing. In addition, the materials have been successfully laminated to a fire-resistant aramid (NOMEX) fabric which provides the necessary fire-protection required by Navy Aviators.

2. It is proposed that 16 experimental garments be fabricated from two material sources and a series of tests be performed to evaluate each material type. It is estimated that $32K will be required to pursue this program. The following tasks would be performed:

a. Material investigation, development and testing } 5.0K
b. Procurement of the experimental fabric }
c. Fabrication of experimental garments 8.1K
d. Immersion testing 7.5K
e. Garment Fire-Pit testing 9.4K

404314

Subj: Experimental Anti-Exposure Suit Program; request funding for

f. Flight Evaluation ~~$9.0K~~

g. Final Report 2.0K

4. Enclosure (1) is submitted for completion of the subject task and for information and retention.

R. N. Taylor

R. N. TAYLOR
By direction

PROGRAM SCHEDULE/MILESTONE CHART

TITLE Experimental Anti-Exposure Suit Program

TASK/EVENT	MONTHS 1	2	3	4	5	6	7	8	9	10	11	12	
IN-HOUSE EFFORT													
Material investigation, development and testing													~~$ 12.0K~~ 8.1K
Fabrication of garments													7.5K
Physiological Testing													9.4K
Fire-Pit Testing													~~9.0K~~
Flight Evaluation													2.0K
Final Report													
IDWA'S/PO'S													
Procurement of the microporous fabrics													$ 7.0K
												TOTAL	~~$55.0K~~ 31.K

AADC-81208-60

B-4

ENCLOSURE 1-3

5311D/LIW
Ser 57
9 MAR 1978

From: Commander, Naval Air Systems Command
To: Commander, Naval Air Development Center

Subj: Gore-Tex Anti-Exposure Suit Material Development, information concerning

Ref: (a) Phonecon between Mr. Ken Troup (ASD/AEL) and Mr. L. Weinstock (NAVAIR) on 20 Jan 1978
(b) Phonecon between Mr. J. Lewyckyj (NADC) and Mr. L. Weinstock (NAVAIR) on 23 Jan 1978

Encl: (1) Copy of NADC ltr 404314 Ser 9345 dtd 19 Nov 76 w/encl.

1. Reference (a) advised the Naval Air Systems Command (NAVAIR), that the USAF Life Support System Program Office (SPO) would make available to the Navy $30,000 for a Gore-Tex laminate material development program. This would be to develop a suitable replacement material for the cotton "ventile" fabric used in the CWU-21/P anti-exposure coverall.

2. As discussed during reference (b), NAVAIR suggests that by revising enclosure (1) proposal with the following changes, an acceptable program can be initiated:

a. Restrict material investigation to Gore-Tex candidate materials only (vice two sources).

b. Eliminate formal Navy flight evaluation except for possible Naval Air Development Center (NAVAIRDEVCEN) flight testing on a non-interference basis.

c. Make available to the USAF the maximum number of experimental garments (funds permitting) for flight/wear testing.

3. It is requested that the SPO be contacted directly (Mr. K. Troup, A/V 785-3000) to arrange for fund transfer and any other details necessary to initiate subject program. Copies of the updated proposal should be submitted to NAVAIR and SPO as soon as the technical/funding details are completed.

J. B. Wildman
By direction

Copy to: w/encl.
WPAFB (ASD/AEL)

NADC-81268-60

MILITARY INTERDEPARTMENTAL PURCHASE REQUEST

1. PAGE 1 OF 1 PAGES

2. FSC	3. CONTROL SYMBOL NO.	4. DATE PREPARED	5. MIPR NUMBER	6. AMEND NO.
		7 Jun 1978	FY7615-78-05168	00

7. TO: N62269-2N
U. S. Naval Air Dev Ctr
Johnsville, Warminster, PA 18974

8. FROM: (Agency, name, telephone number of originator)
ASD/PMOSC (Ext: 255-3270)
Commander AFSC
Aeronautical Systems Division
Wright-Patterson AFB OH 45433

9. ITEMS [ ] ARE [X] ARE NOT INCLUDED IN THE INTERSERVICE SUPPLY SUPPORT PROGRAM AND REQUIRED INTERSERVICE SCREENING [ ] HAS [ ] HAS NOT BEEN ACCOMPLISHED.

ITEM NO. a	DESCRIPTION (Federal stock number, nomenclature, specification and/or drawing No., etc.) b	QTY c	UNIT d	ESTIMATED UNIT PRICE e	ESTIMATED TOTAL PRICE f
1 AA	ADVANCED FABRIC APPLICATIONS a. Investigate hydrophobic (GORE-TEX) laminate fabrics for anti-exposure suits in accordance with attached SOW application.	1	Lot	N/A	
	b. Experimental anti-exposure suits of CWU-21/P style using fabrics developed under AA above.	24	Ea	N/A	
	Program Priority - R MIPR estimate will not be exceeded. Period of Performance Jun-Sep 78 No ALC coordination required.				

FINANCIAL MANAGER: Mary J. Parry, ASD/AEPC, 52409

INITIATOR
Kenneth F. Troup
Program Manager
ASD/AELS, 53000

Lee E Smith
LEE E. SMITH, COLONEL, USAF
Deputy System Program Director
Life Support System Program Office

Julia B. House
JULIA B. HOUSE
Fund Certifying Officer
ASD/ACFC
22 JUN 1978

10. SEE ATTACHED PAGES FOR DELIVERY SCHEDULES, PRESERVATION AND PACKAGING INSTRUCTIONS, SHIPPING INSTRUCTIONS AND INSTRUCTIONS FOR DISTRIBUTION OF CONTRACTS AND RELATED DOCUMENTS.

11. GRAND TOTAL $20,000.00

12. TRANSPORTATION ALLOTMENT (Used if FOB Contractor's plant)
See para # 4 of attached AFSC Form 75

13. MAIL INVOICES TO (Payment will be made by)
See para # 5 of attached AFSC Form 75
PAY OFFICE DODAAD F95600

14. FUNDS FOR PROCUREMENT ARE PROPERLY CHARGEABLE TO THE ALLOTMENTS SET FORTH BELOW, THE AVAILABLE BALANCES OF WHICH ARE SUFFICIENT TO COVER THE ESTIMATED TOTAL PRICE.

ACRN	APPROPRIATION	LIMIT/SUBHEAD	SUPPLEMENTAL ACCOUNTING CLASSIFICATION	ACCTG STA DODAAD	AMOUNT
AA	5783600		298 4720 62412A 002980 00000 64706F 595600	F95600	$20,000.00

15. AUTHORIZING OFFICER (Type name and title)
BARBARA J. HARRIS
Chief, Contract Support Division

16. SIGNATURE
Barbara J. Harris

17. DATE
28 JUN 1978

DD FORM 1 JUN 72 448 PREVIOUS EDITION IS OBSOLETE.

Statement of Work

for

Investigation of hydrophobic breathable laminated fabrics
for Anti-exposure suits

1. Scope

1.1 This statement of work covers the investigation, fabrication and test of hydrophobic breathable laminated fabrics (Gore-Tex) for continuous wear anti-exposure suits.

2. Background

2.1 Current anti-exposure suits worn by USAF aircrews are fabricated of a breathable cotton fabric called "Ventile." This fabric must be obtained from the British as no U.S. source for the weaving of Ventile has been established. The supply of Ventile has not been adequate to keep pace with the total need of the AF. In addition, as the Ventile is woven from cotton, no flammability protection is available and the wear out rate is excessively high. It is hoped that this investigation of Gore-Tex will result in a suit which will eliminate these problem areas.

3. Technical Requirements

3.1 A material investigation shall be made to determine the capability of the Gore-Tex film when laminated to fire resistant fabrics to permit transmission of moisture vapor away from the body, giving greater comfort to the wearer. Literature furnished by the contractor for Gore-Tex shows the moisture vapor transmission to be equal to or better than Ventile. The transmission rate of Ventile should be the base line for any measurements of this characteristic. Passage of liquid sea water thru the fabric should also be investigated to determine the capability of the fabric to prevent water from entering into the suit.

3.2 When a satisfactory fabric has been selected, prototype anti-exposure suits should be fabricated and tested to determine protection from water, cold and heat. In addition, fire pit tests should be accomplished to determine protection from high thermal flux.

3.3 After completion of all testing, 24 suits for operational evaluation should be fabricated.

3.4 A final report should be provided with all test methods and data. Sufficient technical information on the fabric should be supplied to enable preparation of a specification if operational evaluation is successful.

AF PR/MIPR SPECIAL INSTRUCTIONS

This instruction sheet is an integral part of accompanying MIPR and it is not to be detached.

1. INQUIRIES. Inquiries and correspondence regarding this MIPR will be directed to the appropriate office indicated in block 8 of MIPR.

2. ACCEPTANCE. For the convenience of the procuring agency in accomplishing formal acceptance of this MIPR in accordance with current DOD policies, six copies of DD Form 448-2 are attached. The anticipated date of obligation must be shown for those items procured under Category II method of financing *(direct citation of AF funds)*.

3. REQUEST FOR ADDITIONAL FUNDS. Any request for an increase in funds will be forwarded to the office indicated in block 8 of MIPR. The additional funds requested will be expressed as a stipulated dollar amount and not on a percentage basis. All requests will be identified to the MIPR item number*(s)* involved and will state the reason for the required increase. Upon approval of the request, an amendment to the MIPR citing the additional funds will be forwarded to the procuring agency.

4. TRANSPORTATION CHARGES. HQ AFSC/HQ AFLC provide directives relative to the accounting classification, for first destination transportation, directly to the purchasing departments. Individual AF MIPRs will not carry specific citations for first destination transportation.

5. PAYMENTS.

a. Obligations incurred under Category I methodof financing will be paid by the Air Force upon submission of SF 1080, "Voucher for Transfer Between Appropriations and or Funds," with all supporting documents, to the accounting office whose fiscal station number is cited in the accounting classification on this MIPR. The SF 1080 will reference the MIPR number and indicate whether the billing is partial or final. Under no circumstances will the procuring agency certify and process for payment SFs 1080 citing AF funds.

b. Direct citation on Contracts under Category II
(1) When contract is administered by DCAS cite the DCAS Region Disbursing Office. (2) When the contract is administered by NAVPRO/ARMYPRO cite finance office IAW AFSC Sup to ASPR 20-706(b)(1) *(copies of the Sup have been furnished to Army/Navy procuring activities)*.

6. SHIPPING INSTRUCTIONS. Provided names and addresses of consignee of all supplies to be delivered are not contained herein, or otherwise furnished, request for the issuance of shipping instructions will be made to the office indicated in block 8 of MIPR, no later than 30 days prior to date on which any of the articles are ready for shipment.

7. IDENTIFICATION. All documents, acceptances, correspondence, inquiries, shipping documents, work or project orders, etc., and SF 1080 billings, etc., will reference the MIPR number and the MIPR item number. The quantity breakdown by equity *(Air Force, Army, or Navy)* and the applicable accounting classification(s) will also be referenced on all documents resulting from this MIPR.

8. DISTRIBUTION OF DOCUMENTS. Bulk distribution of acceptance, obligation, and shipping documents in the required number of copies as indicated below will be made by the procuring agency to the office indicated in block 8 of MIPR for internal AF distribution.

a. DD Forms 448-2. Original and four copies.

b. Numbered contracts and purchase orders *(DD Form 1155 series)* including modifications and changes, 10 copies, *(including two signed or authenticated copies)* IAW ASPR 5-1111. *(This distribution in no way changes the requirement for the procuring services to distribute a contract IAW ASPR 20-402)*.

c. Shipping documents other than DD Form 250, four copies.

9. SUPPLY TYPE CONTRACTS. All supply type contracts resulting from this MIPR and where inspection is at source, will contain the clause appearing in ASPR 7-105.7.

10. MATERIEL INSPECTION AND RECEIVING REPORTS *(DD Form 250)*. Distribution will be accomplished in accordance with current ASPR requirements. In addition, where special distribution is required, it is shown in block 9 or on an attachment to this MIPR.

11. POINT OF FINAL ACCEPTANCE. A statement clarifying the point(s) of final acceptance will be included in all contracts resulting from this MIPR.

12. WITHDRAWAL OF EXCESS FUNDS BY THE AID FORCE:

a. If this MIPR is accepted for consolidated reimbursable procurement in an amount less than authorized on the MIPR, the DD Form 448-2 is authorization for the Air Force to decommit the excess funds by issuance of a MIPR amendment. After receipt of final billing *(SF 1080)* and subsequent determination that all items have been delivered and billed in an amount less than the MIPR, the Air Force may adjust their funds without authorization from or notice to the procuring department.

b. If this MIPR is accepted for direct citation procurement, any unused funds remaining on the MIPR after initial contract placement is completed will be immediately reported to the Air Force. The Air Force will then issue a MIPR amendment to decommit the excess funds. NOTE: If provisioning is involved, a decommitment amendment with respect to the specific item(s) will not be prepared until after the Air Force has advised the procuring agency that provisioning requirements are satisfied, and a contractual document marked final which definitizes all remaining provisioned items released to the contractor is received by the Air Force.

c. Upon receipt of deobligating contractual documents, the amount of excess funds will be coordinated with the procuring agency and withdrawn by a MIPR amendment.

603

2393

MAR 21 1979

From: Commander, Naval Air Development Center
To: Commander, Aeronautical Systems Division (AEL)
Wright-Patterson Air Force Base, OH 45433

Subj: New Materials for Use in Thermal and Anti-Exposure Protective Clothing; evaluation of

Ref: (a) ASD/AEL ltr of 17 Jan 1979
(b) NAVAIRDEVCEN 6033 ltr ser 3823 of 12 May 1978
(c) MIPR FY-7615-78-05163 of 28 Jun 1978
(d) Fonecon between ASD, Mr. K. Troupe (AEL) and NAVAIRDEVCEN, Mr. E. Boscola (60302) of 21 Feb 1979

Encl: (1) NAVAIRDEVCEN 603 Progress Report, "Evaluation of New Materials for Use in Thermal and Anti-Exposure Protective Clothing" of 12 Mar 1979
(2) NAVAIRDEVCEN Experimental Anti-Exposure Suit Program Milestone Schedule

1. Reference (a) requested that this Center provide the ASD (AEL) with progress reports on the subject program detailing effort accomplished and future plans. It should be noted that program plans as negotiated by references (b) and (c) established a requirement for a final report with no consideration for progress reports. However enclosure (1), which includes progress to date, is forwarded for your information. As agreed during reference (d), progress reports will be forwarded to ASD on a quarterly basis.

2. Enclosure (2) contains a revised program milestone schedule for the planned program events. Milestone slippage was primarily due to obtaining and procurement of the various materials to be investigated. Future plans beyond the scope of this program are dependent upon successful completion of current efforts and further negotiation with ASD.

J. HARDING
By direction

Copy to:
NAVAIR (AIR-5311)

Gen Files
COMDF
60DF
603 Files
60301

6033
60302

E. BOSCOLA,kms,3/~~21~~13/79;2512 (T-M0398)

NAVAL AIR DEVELOPMENT CENTER
AIRCRACT AND CREW SYSTEMS TECHNOLOGY DIRECTORATE
WARMINSTER, PA 18974

603
12 Mar 1979

Progress Report, "Evaluation of New Materials for Use In Thermal and Anti-Exposure Protective Clothing

This program was initiated in August 1978 with the investigation and testing of eight fire-resistant outershell fabric constructions. MVTR (MOisture Vapor Transmission Tests) performed in accordance with the Gore modified prodedure of ASTM E96-66 Method BW showed a transmission valve for the candidate fabrics. The adhesion characteristics were also evaluated and only one candidate, no. 6 of the following table, was determined unacceptable.

Outershell Fabrics

	Weight oz./yd.^{2}	Construction	Yarn	MVTR
1.	1.9	Plain Weave	Staple	6584
2.	3.4	Herringbone Twill	Staple	5506
3.	3.9	Twill	Staple	5433
4.	4.7	Plain Weave(Type 456)	Staple	5052
5.	5.2	2/2 Twill	Filament	3335
6.	5.6	Twill (Calendered)	Staple	4779
7.	5.9	Cavalry Twill	Filament	4024
8.	8.5	Warp Knit(MIL-C-85101)	Filament	4271

In November, four innershell fire-resistant fabrics were evaluated and candidate nine was selected for lamination.

Innershell Fabrics

9.	1.5	Jersey	Staple	7769
10.	3.7	Double Knit	Staple	6156
11.	3.8	1/4" Fishnet	Filament	
12.	9.0	Simplex	Staple	5068

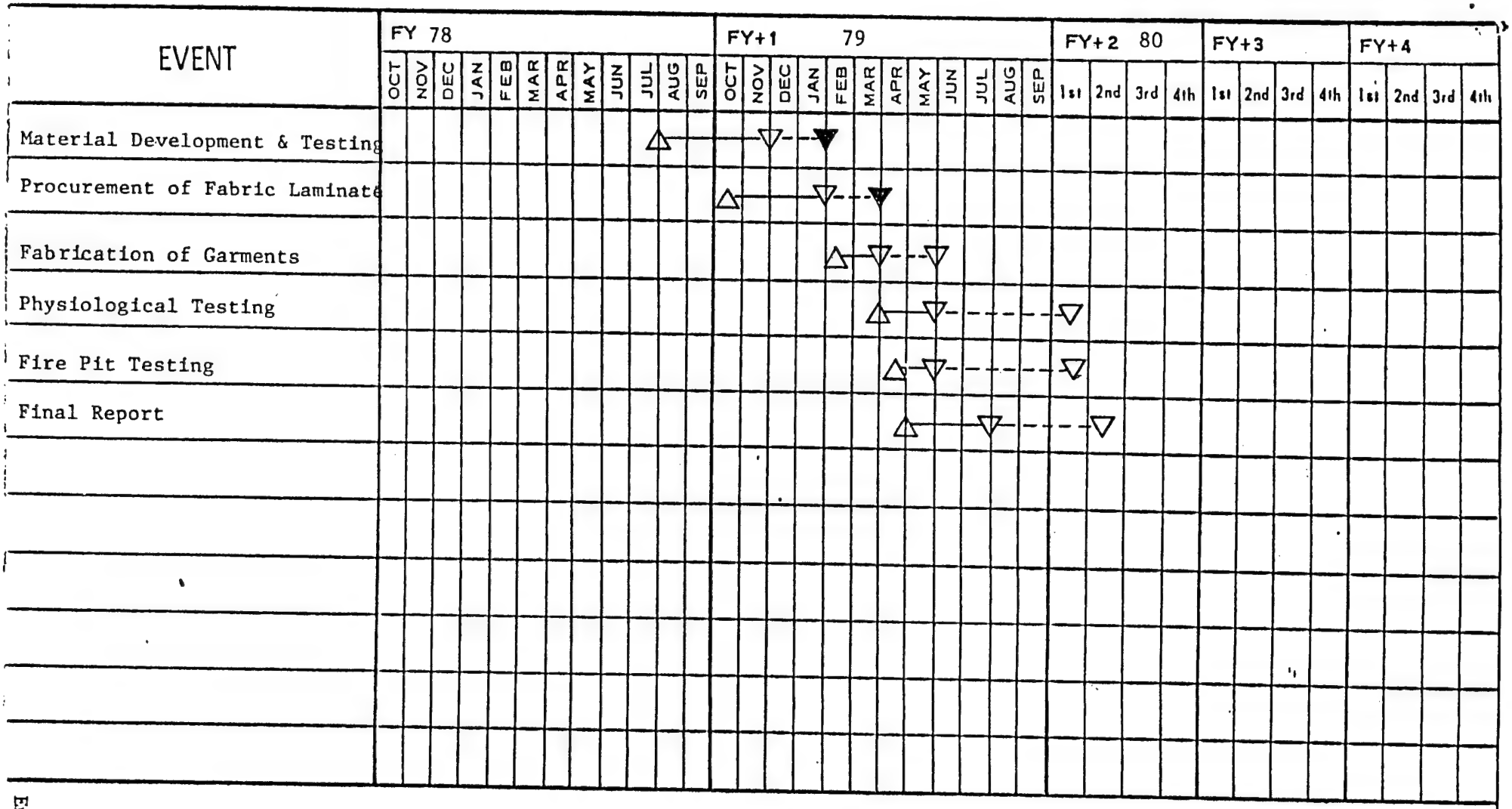
The best shell fabrics (no. 1, 4, 5, and 8) were then chosen for lamination with no. 9 and given to the contractor as GFM.

To date candidates no. 1, 5, and 8 have been laminated but because of purchase order delays candidate 4 has just been purchased. Some problems were experienced during the lamination of the 8.5 oz./yd.^{2} warp knit because of poor manufacturing techniques resulting in very little usable yardage. The manufacturer responded by letter to this Center explaining that at least a 25 percent scrap factor can be expected with such small quantities.

Enclosure (1)

603
12 Mar 1979

This Center is now awaiting the latest patterns from the Defense Personnel Support Center for the manufacturing of the garment which is expected to begin in March and extend into May.



---- Slippage
▼ Completed

Experimental Anti-Exposure Suit Program

MILESTONE SCHEDULE

Enclosure (2)

B-12

NADC-81268-60

ENCLOSURE 4-4

NADC-81268-60

DEPARTMENT OF THE NAVY
NAVAL AIR SYSTEMS COMMAND
WASHINGTON, D.C. 20361

IN REPLY REFER TO
5311D: LIW
Ser 455
24 Oct 1980

From: Commander, Naval Air Systems Command
To: Commander, Naval Air Development Center(Code 606)

Subj: Survivable Fabrics Program (FY-81); information concerning

Ref: (a) Phonecon between Mrs. G. Chisholm (NADC) and Mr. L. Weinstock(NAVAIR) on 17 Oct 1980
(b) Phonecon between Mr. E. Boscola (NADC) and Mr. L. Weinstock(NAVAIR) on 20 Oct 1980
(c) AIRTASK A320320A/001B/1F61542000

1. As discussed during references (a) and (b), NAVAIR has allocated a total of 50K for FY-81 exploratory development of subject materials under reference (c). This funding is to be separated into two separate work units as follows:

   a) Evaluation of New Materials and Blends for use in Thermally Protective clothing 30K
   b) Evaluation of Microporous Laminate Materials for Use in Anti-Exposure clothing 20K

2. It is required that copies of a summary technology work unit program plan be prepared for each and forwarded to NAVAIR (Codes AIR-5311D, and AIR-5163D4) by 14 Nov 1980. The NAVAIR POC for further details on each of these efforts is Mr. Lionel Weinstock, Autovon 222-7480/2.

Mr. G. R. Mutimer
By Direction

Copy to:
NADC (60302, 60033, 603312)

DEPARTMENT OF [illegible]
HEADQUARTERS, 6520TH TEST G[illegible]
EDWARDS AIR FORCE BASE, C[illegible]

20 March 1981

REPLY TO
ATTN OF: 6520 TESTG/ENAH (Capt Calcote/AV 350-4618)

SUBJECT Laboratory Workup on PTFE Suits (DT&E Microporous Antiexposure Suit)

TO Naval Air Development Center
Warminster, Pa.
% Mr. Jules Z. Lewyckyj

1. Enclosed are the two PTFE suits (I.D. #1007, #F) that were discussed in my last project update report (26 Feb 1981). As you indicated during our phone conversation on 3 March 1981, you wanted to do an evaluation of the suits for possible causes of leakage. The evaluation of the suits for the program has just been completed. In addition, I have performed one more fresh water immersion (swimming pool) on the suits for further data collection.

2. On 19 March 1981, both suits were water tested again in the EAFB swimming pool (approx. 15-20 minutes). The results showed the following (see diagrams):

   a. One suit definately leaked at the bottom ¼ of the zipper causing both legs and booties to fillup with water. In addition, the left shoulder area just below the zipper was also wet, thus indicating the zipper leaked in this area as well. The remaining upper torso of the suit was totally dry.

   b. Second suit leaked in the right bootie and around the waist area in front and partially in back. When the suit was inspected, the areas involved were found to have patches (repaired leaks by mfr.). The rest of the suit was totally dry.

   CONCLUSION: The gortex material itself is waterproof as expected. However, besides mechanical problems such as zippers and neck/wrist seals that must be repaired by the mfr., there exists a potential problem with "patched" areas. It may be the method of cleaning weakened the patched areas, causing them to leak. If this is the case, then another method of cleaning/drying will have to be devised.

3. To summarize once again (salt water immersions) for the suits:

Suit I.D. #	Date	Comments
F	3 Feb 81	Totally wet inside. Subject unable to determine route of water entry. Slow onset. Exposure Time: In water: 1043 Out water: 1321 PTFE + CWU-23/P liner + flt/survival gear.
	5 Feb 81	Same as above. Exposure Time: In water: 0934 Out water: 1136 PTFE + Nomex liner + flt/survival gear.
1007	10 Dec 80**	Totally dry inside except minor perspiration at rubber patch areas. Exposure Time: In water: 1010 Out water: 1104 PTFE + average cotton T-shirt/underpants + flt/survival gear.
	3 Feb 81	Leaked badly at lower part of zipper. Subject physically felt water enter at this location (not totally zippered down ??). Exposure Time: In water: 1037 Out water: 1227 PTFE + Nomex liner + flt/survival gear.
	4 Feb 81	Same leakage as above. Checked subject after 4-10 minutes of immersion and found his zipper was not totally zippered down (1/8+" opening at bottom of zipper). Neck seal was taped to eliminate possibility of water leakage in this area. Exposure Time: In water: 1017 Out water: 1201 PTFE + CWU-23/P liner + flt/survival gear.

4. PTFE SUIT HISTORY (See attached chart).

5. If you have any questions/comments, please contact me at your convenience. Please let me know what your lab finds out concerning the suits.

R.D. Calcote

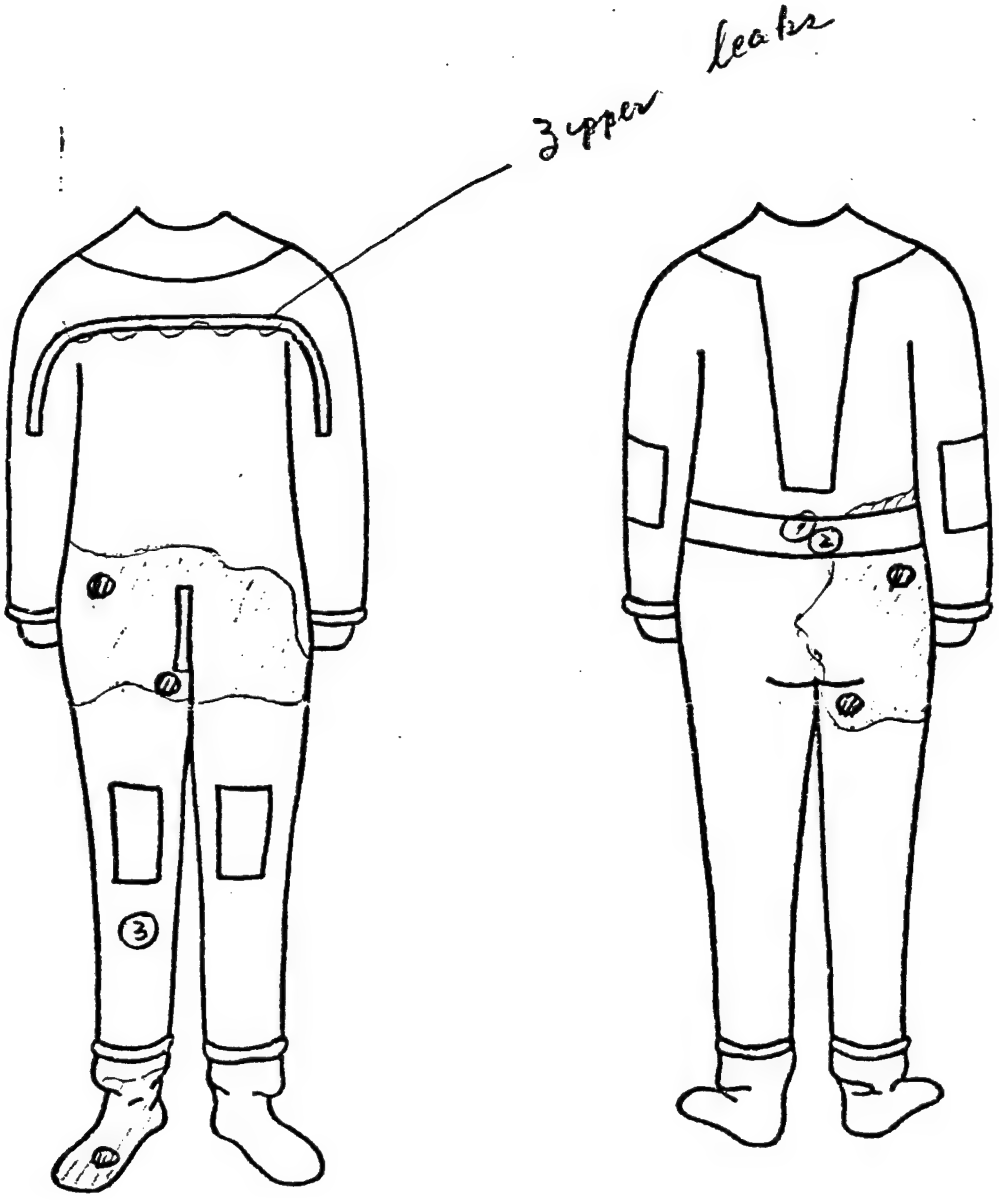
R.D. Calcote, Capt, USAF/Ph.D.
Project Manager

cy to: ENAH
ASD/AES (Ms. Lee Rock)

PTFE SUIT HISTORY

PTFE #	Static Parachute Tower	Parachute Land Jumps	Parachute Water Jump (Lake Isabella)	Swimming Pool	Salt Water Immersions (VAFB)	Static Extended Wear (days)	Machine ** Washings
F	-	-	-	-	2	-	2
	-	-	-	-	-	9	1
	-	-	-	X	-	-	1
1007	X	-	-	-	-	-	1
	-	-	-	X	-	-	1
	-	3	-	-	-	-	1
	-	-	1	-	-	-	1
	-	-	-	-	3	-	3
	-	-	-	-	-	7	3
	-	-	-	X	-	-	1

** Machine washed in mild soap. Rinsed in two cold water rinse cycles. Machine dried, moderate heat, for 10-15 minutes. If not totally dried at that time, suit was air dried.

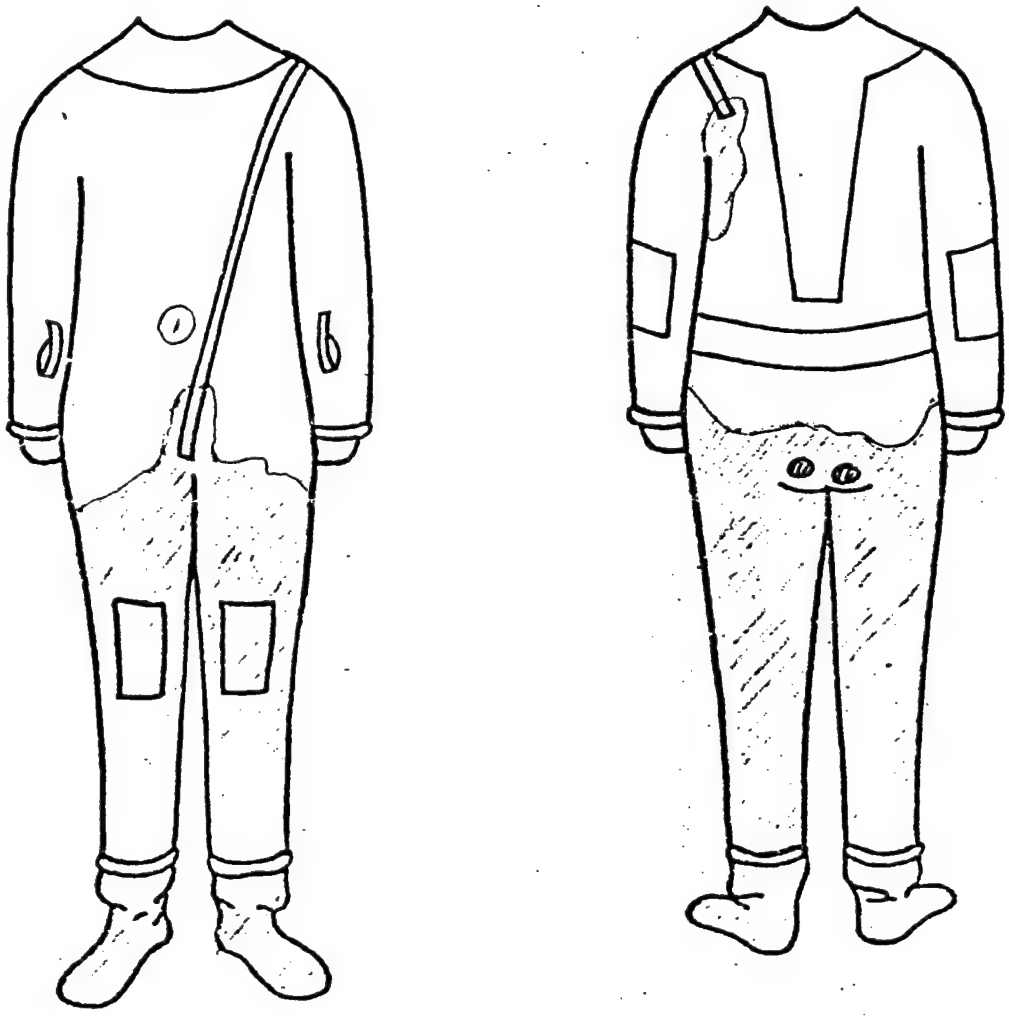


PTFE Suit
(I.D. # F)

③ sharp abrasion

▨ – PATCHED AREAS

▨ – WATER LEAKAGE INSIDE SUIT



PTFE Suit
(I.D. #1007)

① Rash abrasion

▨ - PATCHED AREAS

▨ - WATER LEAKAGE INSIDE SUIT

RTTUZYUW RUEBRDA8474 1611830-UUUU--RUEOFSA.
ZNR UUUUU
R 101930Z JUN 81
FM NAVAIRTESTCEN PATUXENT RIVER MD
TO RUEOFSA/NAVAIRDEVCEN WARMINSTER PA
INFO RULSSAA/COMNAVAIRSYSCOM WASHINGTON DC
BT
UNCLAS //N13520//
SUBJ: SY-78R-81, FIRST INTERIM REPORT, NAVAIRDEVCEN N62269-81-WR-00724 POLYTETRAFLUOROETHYLENE (PTFE) ANTI-EXPOSURE SUIT
A. NAVAIRSYSCOM LTR 5311D:LIW SER 481 OF 21 NOV 1980
B. NAVAIRTESTCEN PROJECT TEST PLAN 13520 SY70C OF 27 MAR 1981
C. MEETING NAVAIRTESTCEN (HMC J. FULTZ/SY-70C)/NAVAIRSYSCOM (MR. L. WEINSTOCK/AIR-5311D) OF 3 JUN 1981
1. THIS MSG SPECIFICALLY FOR NAVAIRDEVCEN, 603312; COMNAVAIRSYSCOM, AIR-5311D.
2. REF A DIRECTED NAVAIRTESCEN TO CONDUCT TEST AND EVALUATIONS ON FIVE DIFFERENT FABRIC WEIGHT PTFE ANTI-EXPOSURE SUITS. REF B DETAILED THE SCOPE OF NAVAIRTESTCEN'S TESTING WHICH INCLUDED ASSESSMENT OF THE TEST GARMENT'S; (1) COMPATIBILITY WITH EXISTING FLIGHT EQUIPMENT, (2) WATER-TIGHTNESS OF WRIST AND NECK SEALS, (3) FABRIC DURABILITY, AND (4) AIRCREW ACCEPTABILITY.

PAGE 02 RUEBRDA8474 UNCLAS
3. REF C REQUESTED NAVAIRTESTCEN SUBMIT PRELIMINARY TEST RESULTS ADDRESSING SPECIFICALLY THE EFFECT OF FABRIC WEIGHT ON THE TEST GARMENTS DURABILITY AND AIRCREW ACCEPTABILITY. A SUMMARY OF HOURS FLOWN FOR EACH TEST GARMENT IS AS FOLLOWS:

FABRIC WEIGHT	QUANTITY TESTED	FLIGHT HOURS FOR EACH GARMENT	TOTAL HOURS
TYPE 1	1	34	34
TYPE 2	3	7, 25, 102	134
TYPE 3	1	55	55
TYPE 4	3	4, 8, 40	52
TYPE 5	1	25	25

4. A DETAILED INSPECTION OF THE PTFE GARMENTS FOR WEAR INDICATES NO SIGNIFICANT DIFFERENCES IN FABRIC DURABILITY BETWEEN THE FIVE FABRIC WEIGHTS EVALUATED. IN ADDITION, ALL FIVE FABRIC WEIGHTS WERE QUALITATIVELY JUDGED ACCEPTABLE BY TEST AIRCREW.
5. A FINAL REPORT OF TEST RESULTS WILL FOLLOW.
6. THE NAVAIRTESTCEN POINT OF CONTACT IS HMC J. FULTZ (SY70C), AUTOVON 356-4141 OR COMMERCIAL (301) 863-4141.
BT
#8474

TOR: 102158Z JUN 81/ER
ACT: 60
-I-: 82

R 101930Z JUN 81

NADC-81268-60

Naval Speedletter

DO NOT CLEAR THROUGH COMMUNICATIONS OFFICE

CLASSIFICATION: UNCLASSIFIED

DATE: 10 Mar 81

IN REPLY REFER TO (ADDRESS & PHONE NO.): 5311D:LIW Ser 8186

INSTRUCTIONS

1. Message type phraseology is permissible.

2. Both addresses must be appropriate for window envelope or bulk mailing, as intended. Include attention codes, when known. Use dots and brackets as guides for window envelope addresses.

3. Give priority to processing, routing, and action required. Avoid time-consuming controls.

4. In order to speed processing, a readily identifiable, special window envelope, OPNAV 5216/145A, Speedletter Envelope, is provided for unclassified speedletters where bulk mailing is not used. Other window envelopes also may be used. In bulk mail, speedletters should be placed on top of regular correspondence.

Commander, Naval Air Development Center
Warminster, Penna 18974

STANDARD REFERENCES AND ENCLOSURES, IF ANY, TEXT AND SIGNATURE BLOCK

Subj: Wear Test Evaluation of Polytetrafluorethylene (PTFE) Anti-Exposure Suits

Ref: (a) NAVAIR ltr 5311D/LIW Ser 481 dtd 21 Nov 1980
(b) Telecon between CDR H. Gregoire (NATC) and L. Weinstock (NAVAIR) on 6 Mar 1981
(c) Telecon between J. Lewyckyj (NADC) and L. Weinstock (NAVAIR) on 9 Mar 1981

Encl: (1) Copy of NATC draft test Plan for PTFE Suits (3960 Ser SY70C/440 dtd 4 Mar 1981)

1. Enclosure (1) is forwarded for review and comments in accordance with reference (a). As discussed during references (b), and (c), the original guidelines remain firm, except for expansion of the scope of work to include rapid decompression testing after completion of the wear testing.

2. The following additional NAVAIR comments are forwarded:

(a) Method of tests should include examination of the laminated material for abrasion, tears, etc. The prime objective of the evaluation is to make a determination of the most durable PTFE material commensurate with comfort and protection.

(b) The questionaire should include some criteria for evaluating above durability in order to aid in final fabric selection.

COPY TO

NAVAIRTESTCEN, PAXRIV

Commander, Naval Air Systems Command
Washington, D.C. 20361

ADDRESS REPLY AS SHOWN AT LEFT; OR, REPLY HEREON AND RETURN

CLASSIFICATION: UNCLASSIFIED

10127(c)
60

81078007

5311D:LIW
Ser 8186

Subj: Wear Test Evaluation of Polytetrafluorethylene (PTFE) Anti-Exposure Suits

(c) The questionaire should also include what underclothing was worn in conjunction with the test garments.

3. Regarding paragraph two of enclosure (1), a possible extension of the wear test past the usual exposure garment season may be necessary in order to obtain sufficient fabric durability data. It is also recommended that NAVAIRDEVCEN consider the suggestion discussed in paragraph three and take whatever action deemed practical.

4. It is requested that NAVAIRDEVCEN continue to coordinate this program at the NAVAIRTESTCEN and maintain close liaison with NAVAIR regarding any changes to the scope of testing.

Mr. G. E. [illegible]
By D[illegible]

NADC-81268-60

DEPARTMENT OF THE NAVY
NAVAL AIR TEST CENTER
PATUXENT RIVER, MARYLAND 20670

3960
Ser SY70C/440
MAR 0 4 1981

From: Commander, Naval Air Test Center, Patuxent River, Maryland 20670
To: Commander, Naval Air Systems Command (AIR-5311D), Naval Air Systems Command Headquarters, Washington, D. C. 20631

Subj: Polytetraflouroethylene (PTFE) Anti-exposure Suit; draft test plan of

Ref: (a) NAVAIRSYSCOM ltr 5311D/LIW Ser 481 of 21 Nov 1980
(b) NAVAIRDEVCEN/NAVAIRTESTCEN mtg of 5 FEb 1981

Encl: (1) Draft Test Plan and Questionnaire

1. In accordance with reference (a), enclosure (1) reflects a three-month program subsequent to receipt of funding. Also contained in enclosure (1) is a draft evaluation questionnaire for review and comment.

2. The guidelines in reference (a), which specify testing duration, preclude adequate durability evaluation due to delay in receipt of the Work Unit and remaining seasonal weather requiring wear of anti-exposure garments.

3. The reference (b) meeting concluded that the evaluation and procurement of flight clothing and personal survival equipment items could be handled more expeditiously in the future if a continuing, generic Work Unit could be issued on a yearly basis to include all flight clothing and survival equipment. Such a once-a-year Work Unit could be incrementally funded as necessary and would eliminate administrative delays in processing individual work units.

R. R. BUEHLER
By direction

81078007

INTRODUCTION

1. The Naval Air Systems Command (AIR-5311D) has an on-going development program to obtain an improved substitute material for the "ventile" cotton fabric now used in the CWU-21/P anti-exposure suit. Several candidate laminated materials using polytetraflouroethylene (PTFE) film sandwiched between fire-resistant aramid fabrics have been selected for further wear testing in prototype anti-exposure garments. Five different fabric weights have been furnished for comparative inflight testing. The Naval Air Test Center (NAVAIRTESTCEN) has been tasked by reference (a) to conduct inflight testing of these new anti-exposure suits and determine the most acceptable of the five candidate materials.

PURPOSE

2. The purpose of this evaluation is to assess: (a) Durability of the prototype PTFE anti-exposure suits; (b) Compatibility with existing flight equipment; (c) Aircrew acceptability; and (d) Water-tightness of wrist and neck seals.

SCOPE OF TESTS

3. Test subjects from the Strike Aircraft Test Directorate, the U. S. Naval Test Pilot School, and the Rotary Wing Aircraft Test Directorate will assess the test garments for a total of 25 flight hours each. Flight testing will be accomplished on a "piggy back" basis (i.e., concurrent with other project flight testing).

METHOD OF TESTS

4. These PTFE anti-exposure suits were received approved for flight from the Naval Air Development Center (NAVAIRDEVCEN). Aircrewmen have been selected in accordance with Table 4-7 of reference (b) for suit sizes 2, 5, 7, and 9. Upon completion of each 25-hour flight test period, questionnaires (see appendix I) will be completed by each aircrewman and the following suit characteristics will be assessed:

a. Durability. Each test garment will be examined to determine the degree of neck and wrist seal wear, sock deterioration, and seam separation, which occur during the limited duration of this evaluation.

b. Compatibility. Test garments will be assessed by aircrewmen postflight questionnaires concerning garment compatibility with the existing flight gear unique to rotary wing and fighter/attack aircraft (see appendix I).

c. Acceptability. Overall garment acceptability will be determined by aircrewmen postflight questionnaires (see appendix I).

d. Water-tightness. Parachute drag (paradrag) drills will be conducted in an indoor swimming pool to determine water tightness of wrist and neck seals. Undergarments will be examined for dryness following the drills. Test subject will also perform parachute releases and LPA-2 activations while being dragged.

PTFE ANTI-EXPOSURE SUIT POSTFLIGHT QUESTIONNAIRE

NAME:_____ RANK/RATE:_____

UNIT:_____ HOURS FLOWN:_____ TYPE(W) A/C_____

DATE_____ OAT (^{o}C)_____

Please coment on each of the following areas after each flight, as applicable:

1. Ease of donning the test suit (circle one). Easy 1 2 3 4 5 Difficult

2. Ease of doffing the test suit (circle one). 1 2 3 4 5

3. Was the test garment worn with an anti-G suit?

   a. If so, were any problems encountered?

   b. If anti-G suit was not worn, why not?

4. If the MA-2 torso harness was worn, was it necessary to go to a next size larger?

5. Was perspiration a problem while the PTFE anti-exposure suit was being worn (circle one)?

NONE	MODERATE	EXCESSIVE
1	2 3	4 5

   a. Discuss if number 3, 4, or 5 was circled?

6. Did you become cold at any time the PTFE anti-exposure suit was being worn (circle one)?

COMFORTABLE	COOL	COLD
1	2 3	4 5

   a. Discuss if number 3, 4, or 5 was circled.

7. Was there any range of motion lost, to any degree, during flight? If so, describe.

8. Overall aircrew acceptability (circle one):

ACCEPTABLE		UNACCEPTABLE		
1	2	3	4	5

9. Remarks/comments.

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